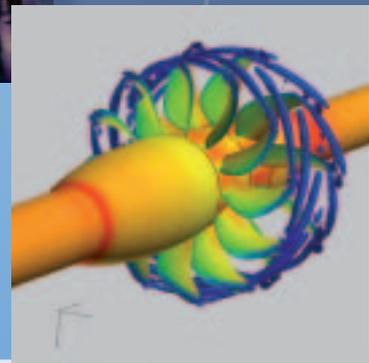**ACARE**

Advisory Council for Aviation Research
and Innovation in Europe

Strategic Research
& Innovation Agenda

Executive Summary

Realising Europe's vision for aviation

Strategic Research & Innovation Agenda

Executive Summary

Maintaining global leadership
Serving society's needs

**Advisory Council for Aviation Research
and Innovation in Europe (ACARE)**

September 2012

Background

Much has changed since the start of the millennium when a first Group of Personalities expressed a vision for European aviation 'Vision 2020', which led to the formation of the Advisory Council for Aeronautics Research in Europe **(ACARE)**.

While the successive releases of the Strategic Research Agenda in 2002, 2004 and 2008 served as guidelines for European research established by the European Commission, member states and public and private stakeholders, a new vision was needed to be developed.

This prompted the sector to set new, more challenging goals and respond to the future needs of Europe and its citizens over a longer timeframe. This new vision, 'Flightpath 2050', was developed by the High Level Group on Aviation Research under the leadership of the European Commission and published in 2011.

It underlines the need for further emissions reductions, recommends maintaining and extending Europe's leadership, enhancing safety and security as air transport needs grow as well as developing excellent research infrastructure and education for the sector.

In response to the recommendations of Flightpath 2050 a new ACARE organisation (**Advisory Council for Aviation Research and Innovation in Europe**) with new membership is now in place. ACARE stakeholders have come together over the last year to develop the **Strategic Research and Innovation Agenda (SRIA)**, presented here, that will enable the aims of the new vision to be achieved.

The strength of ACARE lies in its membership involving the whole air transport and aeronautics community. This collaborative framework is essential in developing an even more successful Air Transport System in Europe.

Further information about ACARE can be found on the following website:

www.acare4europe.org

Foreword

Aviation is recognised as one of the top five advanced technology sectors in Europe. It provides close to nine million skilled jobs, directly and indirectly, and contributes 600 billion Euros to Europe's Gross Domestic Product. Home to some 450 airlines and over 700 airports, European aviation plays a key role in serving society's needs for safe, secure and sustainable mobility – in Europe and all over the world.

Continued growth in European demand for air transport is anticipated for the foreseeable future. More than ever, sustainable mobility is at stake and it is essential that travel is safe, secure, fast, affordable and environmentally friendly. Also, industrial competition is fierce and increasing, not only from established regions but also from new, strong challengers. Finally, the regulatory and taxation environments within and outside Europe have not yet fully converged and prevent a global level playing field.

Maintaining global leadership for aviation in Europe and meeting the needs of citizens are thus the top level objectives that are addressed by 'Flightpath 2050'. This vision for Europe's aviation system and industry is now transposed into a Strategic Research and Innovation Agenda (SRIA) which provides details on the strategy the aviation sector commends to deliver that vision.

We invite all public and private stakeholders in European aviation to consider these priorities in their future research and innovation programmes and we look forward to making 'Flightpath 2050' a reality.

Foreword
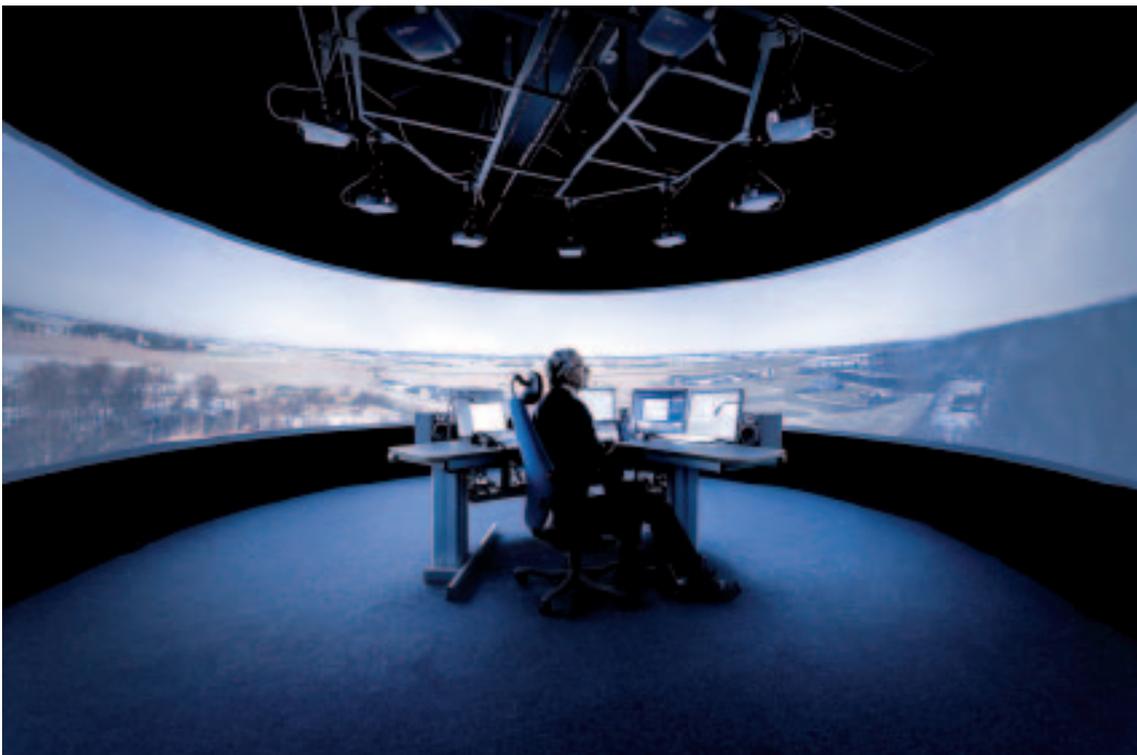
Thomas Enders,
CEO of EADS
Chair ACARE

"Aviation industry has achieved a lot in the last 50 years. Air traffic has grown by 50% in the last decade yet demand for aviation fuel has only risen by 3% – thanks to technology. Research and innovation are key to maintaining Europe's capacities and competitiveness and it is time to align efforts towards the new long-term vision for this sector."

Peter Hartman,
President and CEO of KLM Royal Dutch Airlines
Vice-Chair ACARE

"Aviation makes a substantial contribution to our economies, connecting markets and people worldwide. In the global picture European air transport can solely thrive by an avoidance of overregulation. Only in a global level playing field we can sustain our competitiveness, performance and sustainability. Setting up the priorities for policy, research and innovation will allow European aviation to remain safe, competitive, clean and secure."

Marc Ventre,
Deputy CEO and COO of Safran
Vice-Chair ACARE

"The European manufacturing and service industry is facing new competition and new challenges. To maintain its leadership position, innovation is the key in all areas. Through innovation, we will preserve jobs in Europe, reduce the impact on the environment and increase our market share."

Johann-Dietrich Wörner,
Chairman of the executive board DLR
Vice-Chair ACARE

"Aeronautics has an important role to play in reducing noise as well as greenhouse gas emissions to support sustainable traffic growth. Research, technology and innovation are essential catalysts for a competitive and sustainable future and we need to start quickly to be effective."

From a new vision to a strategic research and innovation agenda

In the last decade, Europe's leadership in aviation has been underpinned by a **commonly shared vision and an associated strategic research agenda**. This proven methodology is deployed once more and extended to a new time horizon.

The new **Flightpath 2050** vision address-es two parallel objectives: firstly to **serve society's needs** for safe, more efficient and environmentally friendly air transport; and secondly, to **maintain global leadership for Europe in this sector** with a competitive supply chain including large companies and small and medium size enterprises. The vision identifies goals to reach these objectives and recommends addressing the following key challenges:

Challenge 1:
Meeting market and societal needs

Challenge 2:
Maintaining and extending industrial leadership

Challenge 3:
Protecting the environment and the energy supply

Challenge 4:
Ensuring safety and security

Challenge 5:
Prioritising research, testing capabilities and education.

According to this vision, in 2050, aviation serves society, brings people together and delivers goods through safe and secure,

Executive Summary

seamless, cost effective transport chains, adding value through speed, reliability and resilience in a global network. It has a good track record on reducing environmental impacts and contributes to society in other critical, non-transport areas such as climate monitoring, emergency services, search and rescue and disaster relief.

In its determination to meet the highly ambitious goals set by Flightpath 2050, the Advisory Council for Aviation Research and Innovation in Europe (ACARE) has developed a new **Strategic Research and Innovation Agenda (SRIA)**.

Innovation in aviation is complex, capital intensive and takes time, partly driven by very stringent certification requirements, consistent with the paramount importance of safety in the sector. Typically, 15 years can elapse between the generation of a concept and technology being fully developed for a specific application on the next generation of air vehicles. In addition, a shift to a more customer centric and lower carbon operation has to be achieved

requiring new airport operational concepts and development and the use of fuels fit for the future. Infrastructure development is dependent on the availability of excellent research, testing and validation capabilities. Vehicles additionally require platform integration and full-scale demonstration. For such reasons, the SRIA roadmap is phased over three timescales:

1. Short-term – to 2020
2. Medium-term – to 2035
3. Long-term – to 2050

The precise timing of implementing innovative solutions into new air vehicles, operations and services will be driven by the willingness of society to accept the change, the capacity of the market to afford the change and the capability of innovators to deliver it.

The European aviation world will also need to be underpinned by an **efficient and effective policy and regulatory framework** that addresses governance, funding and financing issues as a pre-requisite for the Vision 2050 to be realised. This framework should recognise the significant value of aviation to our economies and make sure European companies compete on a level playing field with their worldwide competitors.

The following sections provide an overview of the areas in which research will be conducted. The full SRIA document comprising Volume 1 and Volume 2 contains the comprehensive set of goals and actions that are required to address the five key challenges.

Challenge 1:
Meeting societal and market needs

Sustainable mobility is essential for Europe's economic development and social well-being. Synergies between good connectivity, wealth and prosperity, cohesion, international relations and stability are long-established and well-known.

Air transport must continue to support economic growth and add value at European, regional and local levels by providing the connectivity required by business, tourism and leisure, as well as providing local employment.

Targets by 2050

• **European citizens are able to make informed mobility choices.**

• **90% of travellers within Europe are able to complete their journey, door-to-door within 4 hours.**

• **A coherent ground infrastructure is developed.**

• **Flights land within 1 minute of the planned arrival time.**

• **An air traffic management system is in place that provides a range of services to handle at least 25 million flights a year of all types of vehicles.**

Key action areas

The following enablers are needed to achieve the goals:

1. Design of a customer-centric intermodal transportation system: including, for example, knowing future customer profiles and expectations as well as market and societal opportunities and acceptance factors, identifying the benefits and implementation issues of new mobility system concepts, design of the total transport system architecture, mobility performance assessment and forecast as well as innovative infrastructure planning methodologies.

2. Travel process management: to provide the customer a single ticket for the entire journey as well as travel information capable of delivering robust, relevant, complete and unbiased travel choice before and during a journey. This will also involve enhancing crisis management to mitigate the impacts of serious disruption by providing customers with a robust management and recovery mechanism as well as protecting their rights and interests.

3. Integrated air transport: offering customers a vastly improved seamless travel experience, integrating the points of arrival and departure of all types of air vehicles with other modes of transport, mitigating their impact on their neighbours, strategic and tactical air traffic management and supporting information, communication, navigation and surveillance infrastructure, and delivering system intelligence and autonomy.

Challenge 1

Challenge 2:
Maintaining and extending industrial leadership

The European industry is currently a world leader in aviation and contributes very positively to European economic welfare. Decision makers, stakeholders and society have recognized the strategic role of this industry and the need to maintain and extend its leadership through an appropriate and balanced regulatory framework putting European companies on a level playing field with their competitors from all over the world.

This leadership position will be maintained and extended by Europe's industry remaining innovative and competitive, developing and delivering high quality products quickly and efficiently, meeting time-critical market demands and serving the customers' needs for passenger, freight and non-transport services such as maintenance, repair and overhaul (MRO) and air traffic management (ATM). In 2050, innovative products and services demanded by the market are based on state of the art design, manufacturing and certification processes as well as support tools. They are underpinned by partnerships between manufacturers, airlines, MRO operators, airports, and air navigation service providers working together and collaborating with other modes of transport. Global regulation and standardization is strongly influenced by Europe, is light touch, streamlined and results in a global level playing field in the market for both products and services.

Research and innovation are supported by strong, coherent European research networks and partnerships between the relevant private and public actors, including industry, research institutes, universities and government.

Targets by 2050

• The whole European aviation industry is strongly competitive, delivers the best products **and services worldwide** and has a share of more than **40% of its global market**.

• Europe has retained **leading edge design, manufacturing and system integration capability** and **jobs** supported by **high profile, strategic, flagship projects and programmes** which cover the whole innovation process from basic research to full-scale demonstrators.

• **Streamlined systems of engineering, design, manufacturing, certification and upgrade processes** have addressed complexity and significantly **decreased development costs** (including a 50% reduction in the cost of certification). A leading new generation of standards is created.

Challenge 2

Key action areas

The following enablers are needed to achieve the goals:

1. Continuous development of **new technologies**, new vehicles and their demonstration and flight test.

2. Efficient development and manufacturing process featuring seamless integration of design and manufacturing capabilities.

3. Continued and focussed investment in Research and Innovation to be at the forefront of new technologies.

4. A fair and balanced set of global **regulations and standards** to create a global level playing field.

5. Innovative business models, regulations and incentives to accelerate innovation.

**6. Efficient certification of aviation products**.

Challenge 3:
Protecting the environment and the energy supply

Aviation has an important role to play in reducing greenhouse gas emissions as well as noise and local air quality issues. Although in global terms, the aviation industry is responsible for around 2% of human-induced carbon dioxide emissions, this may increase in proportion as other sectors move to "de-carbonise", and as demand for air transport in Europe continues to grow.

The goals set by Flightpath 2050 in this area are profoundly ambitious and will only be met if better methods and processes facilitate the search for new solutions. More efficient aircraft and engines will need to be developed and integrated in radical new configurations to improve fuel efficiency and address climate change. Better operational and flight management procedures will also be needed to improve air traffic management efficiency. Improved maintenance technologies will also help to prevent degradation of fuel efficiency in ageing aircraft and thus reduce the flying fleet's emissions. Improved understanding of non-CO_2 contributions to climate change - including NO_X, particulates, and contrails and their dependence on operational parameters - will enable the sector to take a 'cradle to grave' approach to protecting the environment and the energy supply in aviation.

Targets by 2050

• **CO_2 emissions per passenger kilometre have been reduced by 75%, NO_X emissions by 90% and perceived noise by 65%**, all relative to the year 2000.

• **Aircraft movements are emission-free when taxiing.**

• **Air vehicles are designed and manufactured to be recyclable.**

• **Europe is established as a centre of excellence on sustainable alternative fuels,** including those for aviation, based on a strong European energy policy.

• **Europe is at the forefront of atmospheric research** and takes the lead in formulating a prioritised environmental action plan and establishes global environmental standards.
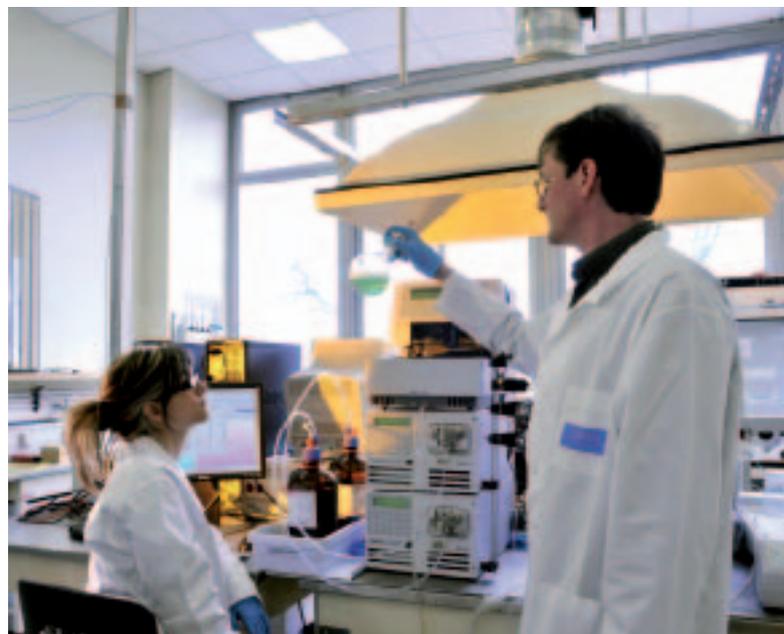
Key action areas

The following enablers are needed to achieve the goals:

1. Dynamic allocation of targets between stakeholders, permanent survey of research results and regularly **updated research priorities**.

2. Extraordinary technological effort to **define the air vehicles of the future**.

3. Improved air operations and traffic management, achieved initially through the deployment phase of SESAR, allowing for short/medium-term traffic growth in Europe.

4. Improved airport environment (including heliports) which, being at the heart of the intermodal transport system, must deliver a service that meets the needs of passengers while mitigating its environmental impact.

5. Availability of affordable, sustainable, alternative energy sources for commercial aviation which will depend on liquid hydrocarbons for at least several decades.

6. Mastering aviation's climate impact to allow low impact operations planning, deeper analysis of the formation/dissipation of contrails and induced cirrus clouds and their contribution to global warming to evaluate the actual environmental impact of a given flight and to optimise flight operations according to atmospheric conditions.

7. Incentives and regulations that create the right framework to promote environmentally friendly behaviour as a part of business-as-usual throughout all lifecycle phases from new aircraft design and development, over the whole operational period, up to aircraft end-of-life.

Challenge 3

Challenge 4:
Ensuring safety and security

Aviation of the future, as a diversified and integrated transport system, will be tightly interwoven with other transport modes – surface and waterways. Methodologies need to identify the emergence of future risks such as cyber threats and data integrity and to accommodate these through improved design, manufacturing and certification processes.

New technologies will increasingly change the dynamic of design, operation, management and regulation of the air transport system. New standards and procedures will be required and a system-wide Safety and Security Management System will be implemented to operate throughout the whole chain of air transport activities.

The human dimension needs significant attention to ensure that in the future air vehicles, procedures and supporting systems are designed for the individual. The air transport system must demonstrate resilience in its response to safety or security threats, based on an understanding of human and organisational performance and how to infuse a positive safety culture at all levels and respond to a fast changing scenario.

Research must anticipate a more fully integrated interdependent system across all transport modes to identify, address and overcome the emergent characteristics of complex system operations.

Targets by 2050

• Overall, the European Air Transport System has **less than one accident per ten million commercial aircraft flights**.

• **Weather and other environmental hazards are precisely evaluated and risks are properly mitigated.**

• **Air Transport operates seamlessly through interoperable and networked systems allowing manned and unmanned air vehicles to safely operate** in the same airspace.

• **Efficient boarding and security measures allow seamless security for global travel. Passengers and cargo pass through security controls without intrusion.**

• **Air vehicles are resilient by design** to current and predicted on-board and on-the-ground security threat evolution, internally and externally to the aircraft.

• **The Air Transport System has a fully secured global high bandwidth data network,** hardened and resilient by design to cyber-attacks.

Key action areas

Enablers covering the following aspects are detailed to achieve the goals:

1. Expectations by society for levels of safety and security, the associated burdens and the need to provide privacy and dignity.

2. Air vehicle operations and traffic management particularly relating to cyber threats and the integration of autonomous vehicles into airspace.

3. Design, manufacturing and certification to include safety and security at all stages.

4. Human factors accounting for re-alignment of responsibility and the balance of decision making between the human and the machine.

Challenge 4

Challenge 5:
Prioritising research, testing capabilities and education

Aviation is a high-technology sector which combines extraordinary demands on research and innovation with long lead times. Decisions in R&D may have consequences on the future of the aviation sector decades after they have been made.

To maintain its world-leading position and competitiveness in the dynamic global market, Europe's aviation sector must be underpinned by world class capabilities and facilities in research, test and validation, and education as well as a world-beating workforce.

Targets by 2050

• **European research and innovation strategies are jointly defined by all stakeholders,** public and private, and implemented in a coordinated way with individual responsibility. This involves the complete innovation chain from blue sky research up to technology demonstration.

• **A network of multi-disciplinary technology clusters** has been created based on collaboration between industry, universities and research institutes.

• **Strategic European aerospace test, simulation and development facilities are identified, maintained and further developed.** The ground and airborne validation and certification processes are integrated where appropriate.

• Students are attracted to careers in aviation. **Courses offered by European Universities closely match the needs of the Aviation Industry,** its research establishments and administrations and evolve continuously as those needs develop. Lifelong and continuous education in aviation is the norm.

Key action areas

The following enablers are needed to achieve the goals:

1. Optimisation of the research and innovation lifecycle: encompassing the full European aviation sector, defining research roadmaps which cover all the successive steps of the innovation cycle.

2. Modern infrastructure: high quality R&D infrastructure as a fundamental pillar of efficient high-technology research, ranging from wind tunnels to experimental aircraft, all organized in a network for use by all stakeholders.

3. A skilled workforce: possessing the quality, skills and motivation to meet the challenges of the future; and being supported by a harmonised and balanced approach covering the entire scope: from **attracting talent** over primary and secondary **education** to apprenticeship, academia and life-long professional development.

Challenge 5

Recommendations

To achieve the Flightpath 2050 goals for European Aviation, Europe must:

• **Lead the development of an integrated resilient European air transport system** that will meet the mobility needs of European citizens as well as the market needs.

• **Maintain global leadership** for a sector that is highly advanced and anticipated to grow.

• **Establish efficient and effective policy and regulatory frameworks,** which ensure a global level playing field and allow European industry to prosper and compete fairly under market conditions in order to **stimulate research, technology and innovation**.

• Put in place incentives, which are accompanied by **long-term programmes with continuity across R&T efforts over many years**. This requires developing mechanisms that provide public sector investment both at European and national level, complemented by public/private partnerships.

• **Champion sustainable growth** so that noise and greenhouse gas emissions can be further reduced and innovative, affordable, alternative energy sources can be developed.
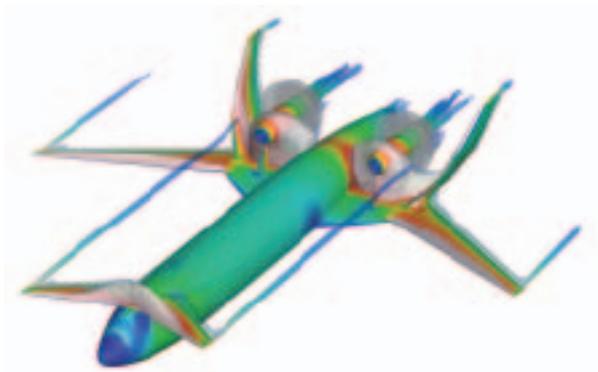
• **Maintain the sector's safety track record** and enable solutions to increasing security risks to be 'built-in' to future designs.

• **Provide long term thinking** to develop state of the art infrastructure, integrated platforms for full-scale demonstration and meet the critical need for a qualified and skilled workforce for today and the future.

ACARE has demonstrated the strength of working closely together across the whole aviation community including air transport, the manufacturing industry, research establishments, universities, regulatory authorities, Member States and the European Commission.

ACARE stakeholders are committed to continue playing a pivotal role in **providing the means for collaboration and cooperation** at a European and global level.

Today **Europe is a world leader in aviation**: the SRIA represents a vital contribution to maintaining and expanding this excellence in the future and provides guidance on the research, development and innovation needed to deliver the Flightpath 2050 vision.

Recommendations